GB 2292186A

(12) UK Patent Application (19) GB (11) 2 292 186 (13) A

(43) Date of A Publication 14.02.1996

(21) Application No 9415321.0

(22) Date of Filing 29.07.1994

(51) INT CL[6]
F01C 1/44

(52) UK CL (Edition O)
F1F FEC FEE FEH FEK FEV FEW F1A3

(56) Documents Cited
GB 1545583 A GB 1383812 A GB 1358162 A

(58) Field of Search
UK CL (Edition N) F1F FD FEC FEH FEW
INT CL[6] F01C 1/40 1/44, F04C 2/40 2/44 18/40 18/44
ON-LINE: WPI

(71) Applicant(s)
John Richard Neville Roe
Ardlogie House, FYVIE, Aberdeenshire, AB5 8PD, United Kingdom

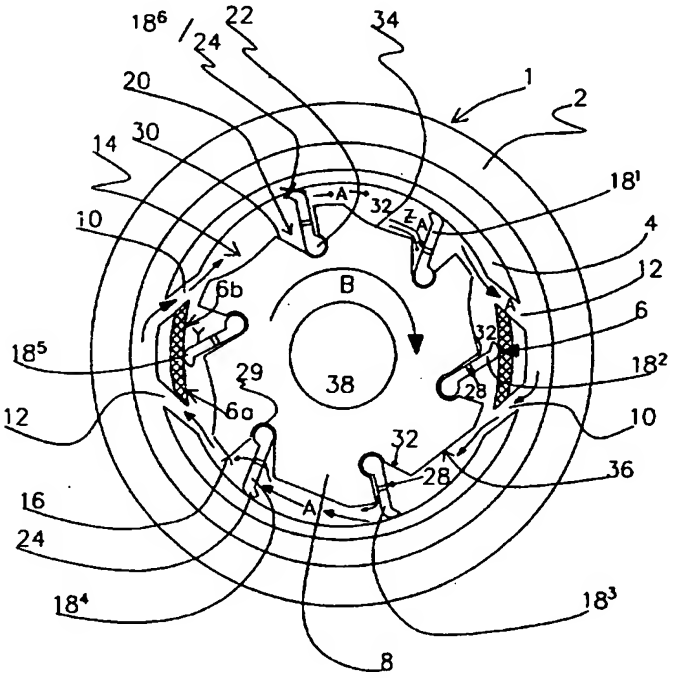
(72) Inventor(s)
John Richard Neville Roe

(74) Agent and/or Address for Service
John Richard Neville Roe
Ardlogie House, FYVIE, Aberdeenshire, AB5 8PD, United Kingdom

(54) Hinged vane motor

(57) In a hinged vane motor a tubular outer casing 2 is provided with a stator 4 in which a rotor 8 is mounted for rotation, the stator 4 having angularly spaced apart inlet 10 and outlet 12 for ingress of working fluid to vanes 18 in chamber 14 and egress of fluid from the chamber 14, the outlet 12 being separated from the inlet 10 by wall means (44, Fig 2). The stator has vane deflectors 6 extending substantially into contact with the said rotor at an angular position between the outlet 12 and inlet 10. The vanes 18 have fluid transfer ports 28 to communicate between the leading and trailing faces. Longitudinal grooves (27, Fig 5) provide a lubricant reservoir. The vanes may easily be reversed when worn by having the hinge and tip portions similar in form. Bore 38 in the rotor 8 allows lubricant or coolant to reach a drill bit (40, Fig 2).

Fig. 1



GB 2 292 186 A

Fig. 1of 6

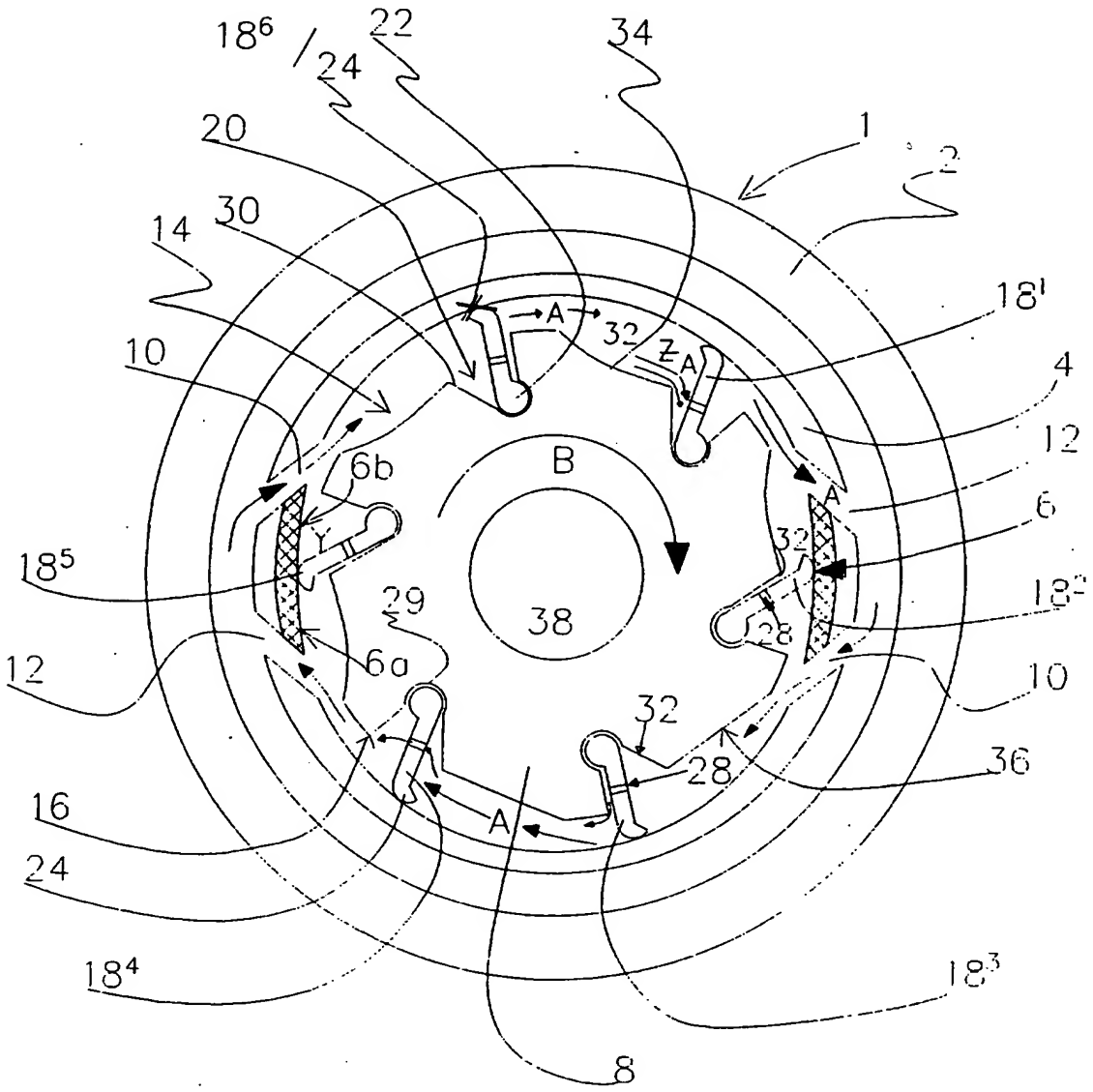

18⁶
24
22
34
20
1
2
14
30
18¹
10
A
32
Z_A
4
12
6b
B
A
6
18⁵
32
29
38
18²
28
12
6a
10
32
28
36
16
A
24
18⁴
18³
8

Fig. 2 of 6

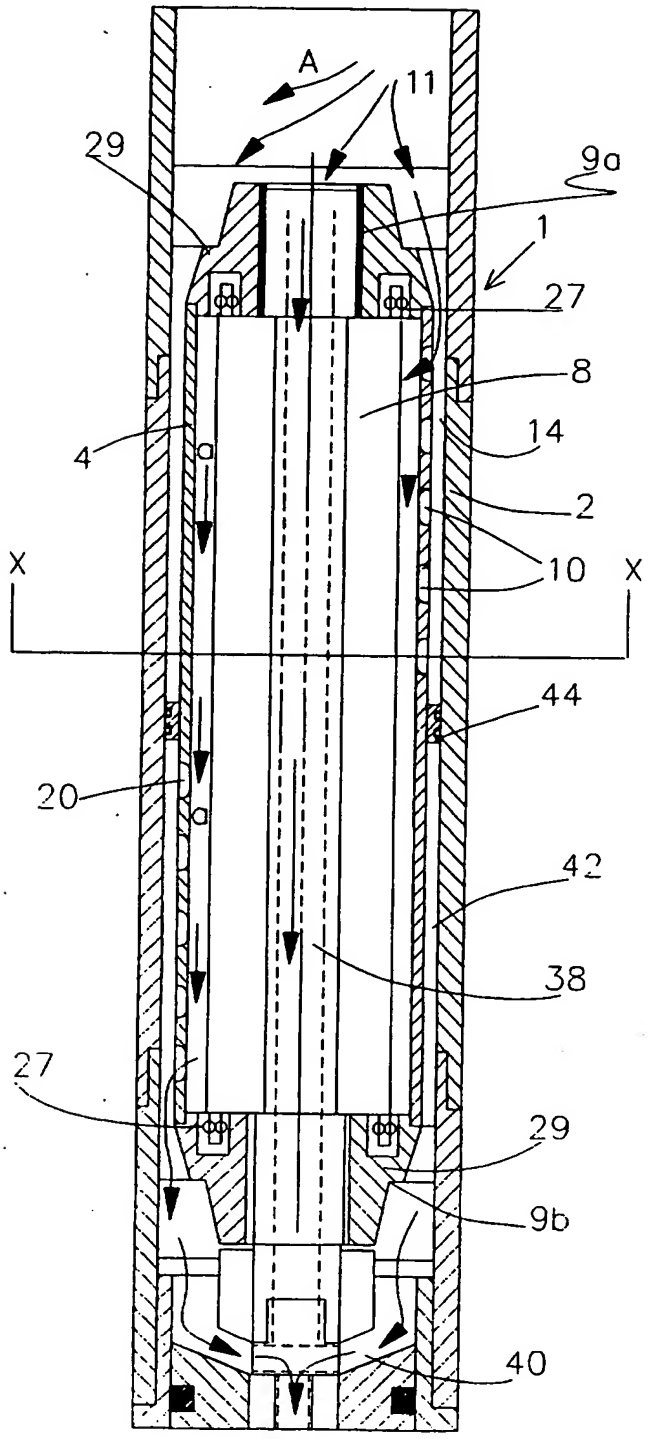


Fig. 3 of 6

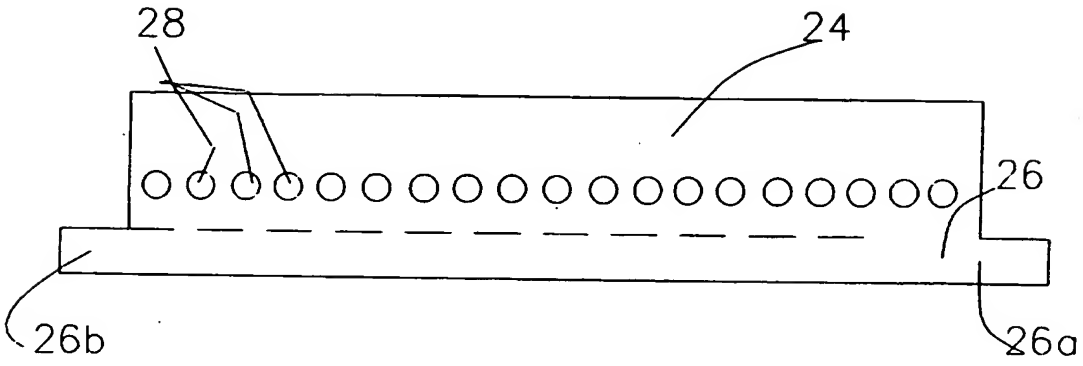


Fig. 4 of 6

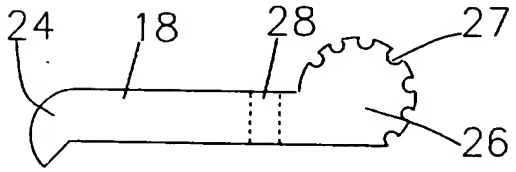


Fig. 5 of 6

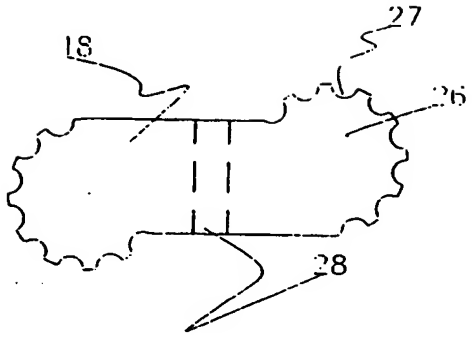
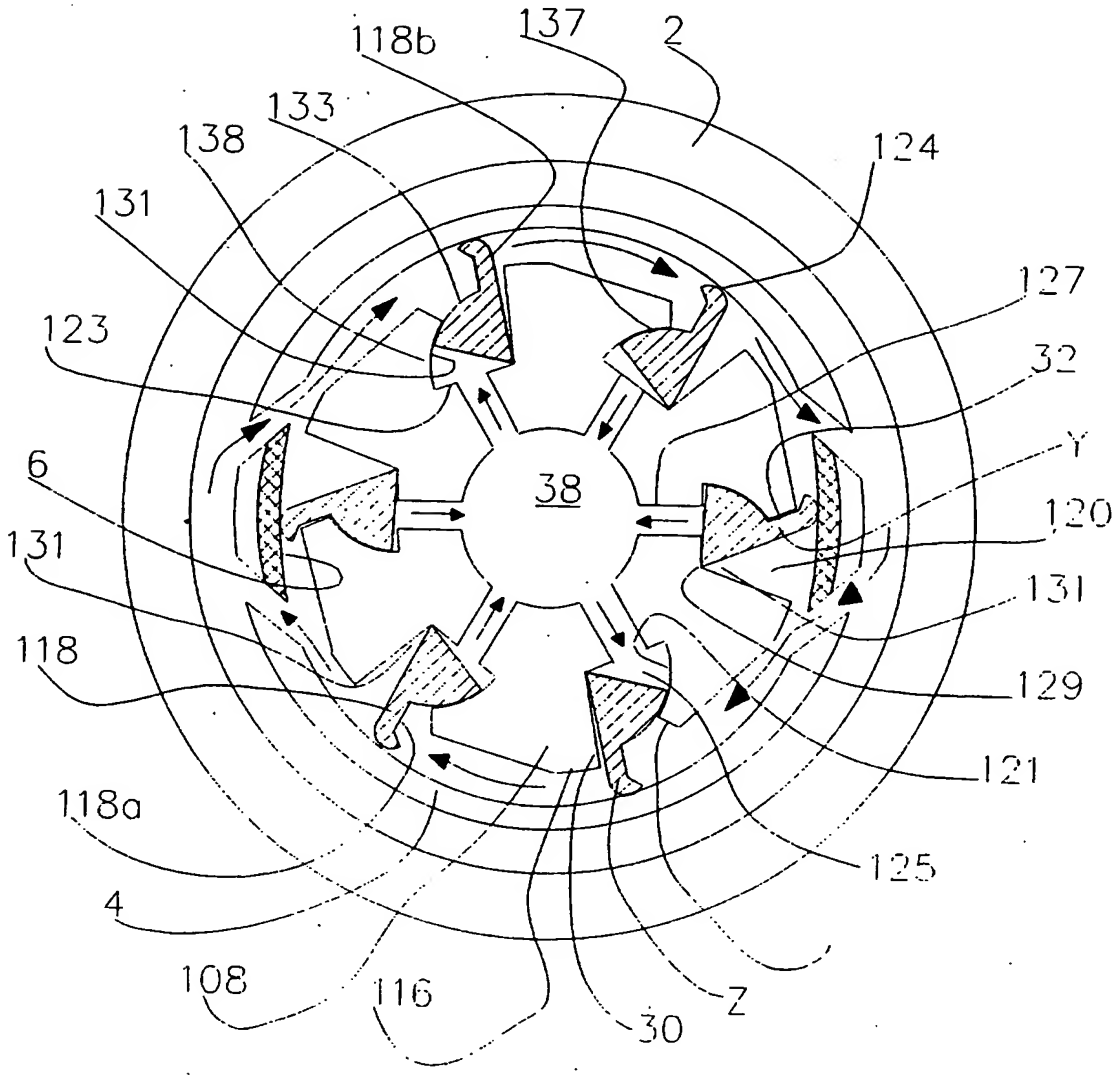


Fig. 6 of 6


118b
137
2
133
138
124
131
127
123
32
Y
6
38
120
131
131
118
129
121
118a
125
4
108
116
30
Z

HINGED VANE MOTOR

The invention relates to a hydraulically or pneumatically driven vane motor especially but not exclusively for use as a drilling tool in the oil, mining or civil engineering industry for directional including horizontal as well as straight hole drilling or as a top drive to drive a "Drill String". Down hole motors as generally used in the oil and mining industries suffer from the disadvantages that they are very long, heavy and expensive to manufacture.

It an object of the present invention to avoid or minimise one or more of the above disadvantages.

The present invention provides a vane motor of the type suitable for use in down-hole drilling applications, which motor comprises a generally tubular casing and a rotor mounted for rotation within said casing with a chamber therebetween, said casing being provided with angularly spaced apart inlet means and outlet means for ingress of pressurised working fluid from inlet conduit means in said casing into said chamber and egress of said fluid from within said chamber, to outlet conduit means separated from said inlet conduit means by wall means in use of the motor, said casing having at least two generally radially inwardly extending wall means each extending substantially into contact with said

rotor at an angular position between a said outlet means and a said inlet means, said rotor having a plurality of angularly spaced apart generally strip-form vane means, with enlarged thickness root portions said vane means being mounted in generally radially extending generally V-shaped section recesses in said rotor with undercut root channels formed and arranged for captively retaining therein said vane means root portions so as to allow said vane means to be hingedly displacable in said recesses between a generally radially projecting position in substantially sealing engagement with the casing to a rearwardly inclined and radially inwardly retracted position when traversing the radially inwardly extending wall means, said radially inwardly extending wall means having a rising portion which progressively approaches the rotor, and a falling portion which recedes from the rotor, whereby in use of said motor, a flow of pressurised fluid into said chamber acts against an upsteam side of a first said vane means in a substantially projecting position thereof so as to rotate said rotor while venting fluid from its downstream side until said vane means traverses said outlet means and is driven towards its retracted position and a second said vane means traverses the inlet means whereupon said process is repeated.

Advantageously, the casing is in the form of inner and outer casings with the inlet and outlet conduit means defined therebetween. Preferably the inlet and outlet conduit means are longitudinally spaced at opposite sides of an annular wall.

Preferably said rotor is mounted concentrically in said casing for rotation therein.

Said generally strip-form vane means is advantageously in the form of an elongate vane having a generally circular section enlarged thickness root portion key-mounted in a generally complementary undercut root channel in the rotor recess. The vanes or vane portions have preferably a plurality of spaced apart fluid transfer ports for reducing resistance to hingeing movement of the vanes/vane portions between the leading and trailing sides of the recesses by allowing fluid to pass between one side and the other of the vanes/vane portions.

Advantageously, or instead of using circular section key-mounted root portions, the vanes may have wedge-shaped section root portions mounted in undercut, enlarged angular extent, root channels formed and arranged so that at least part of the enlarged thickness vane root portions is at all times held under at least

the outermost part of the "overhang" defining the undercut root channel.

Desirably, at least in those cases, where a wedge-shaped section vane root portion is used, passage means are provided inside the rotor for conveying working fluid to and from a central axial bore extending through the rotor for supplying working fluid to drill bits etc. located at the distal end of the motor for lubrication thereof. More particularly fluid may enter the undercut channel behind the vane to help forward movement thereof, and be displaced from the undercut channel behind the vane to facilitate rearward retraction thereof.

Preferably said vane means root portion is provided with longitudinal and/or circumferential grooves so as to reduce friction when said vane means is hingedly swinging in said undercut root channels of said recess. Said grooves also serve to provide a reservoir for lubricating fluid to lubricate the root portion of the vane means in said generally circular-section undercut root channels of said rotor. Said root channels are preferably heat treated so as to give a hardened bearing surface for co-operating with said shaft and hinging thereof.

Each said vane means has a tip portion formed and arranged for sealing engagement with the casing. Preferably said tip portion is partially arcuate so as to provide an increased contact area between said tip portion and said casing. The novel form of captive mounting of the vane means also has the advantage that the vane means are readily replaceable when said tip portion has become worn through prolonged use. Desirably there is provided a vane means having a generally circular section enlarged thickness "root" portion at each end thereof and formed and arranged so that once the "tip" portion has become worn then the vane means may be simply reversed so as to place the worn "tip" portion into said enlarged thickness root portion of said recess to function as the "root" portion of the vane means, whilst that which had previously served as the "root" portion of the vane means can become a new "tip" portion for improved sealing engagement with the casing.

Said vane means or at least said vane portion thereof is preferably made from a more or less flexible resiliently deformable material such as PTFE or PEEK polymeric material, or vulcanised neoprene, desirably with metal reinforcement. Preferably said shaft is made of metal and said metal reinforcement for said vanes is integral therewith. Said shaft of said vane means preferably

extends beyond each end of said vane portion and is mounted in roller or ball bearing recesses in an end suspension plate at each end of said rotor.

Said generally V-shaped section recesses comprise a leading face and a trailing face inclined towards each other preferably at an angle of from 30° to 60° most preferably from 35° to 50° e.g. about 40°. When said vane means is in said substantially projecting position thereof, the downstream side of said vane means abuts against said leading face of said V-shaped section recess. When said vane means is in said rearwardly inclined and radially inwardly retracted position the upsteam side of said vane means abuts against the trailing face of said recess. Preferably the outer circumference of the rotor adjacent said trailing face is somewhat recessed with a shallow concave-section groove so as to increase the volume of said chamber defined between said rotor and said casing. It has been found that by utilising said increased volume chamber together with an increased size of fluid transfer ports in said vanes, it is possible to achieve an increased throughput of working fluid especially for relatively high viscosity working fluids such as drilling mud and thereby to provide a motor having improved power and torque characteristics (?). Furthermore the use of high viscosity working fluids such as heavy drilling muds

provide for improved sealing between working parts thereby allowing the use of less stringent dimensional tolerances between working parts. This is particularly desirable in down-hole environments where very high wear rates are encountered.

Preferably the rotor is provided with a central axial bore which allows part of the fluid flow to pass though the motor for cooling and/or lubrication purposes.

Further preferred features and advantages of the present invention will appear from the following detailed description given by way of example of some preferred embodiments illustrated with reference to the accompanying drawings in which:-

Fig. 1 is a sectional end view (about line X-X of Fig. 2) of a vane motor in accordance with the present invention;

Fig. 2 is a sectional side view of the motor of Fig. 1;

Fig. 3 is a side view of a vane of the vane motor of Fig. 1;

Fig. 4 is an end view of the vane in Fig. 3; and

Fig. 5 is an end view corresponding to that of Fig. 4 of a modified embodiment; and

Fig. 6 is a view similar to Fig. 1 of a further embodiment.

A vane motor in accordance with the present invention, as shown in Figs. 1 and 2 and generally indicated by reference number 1, comprises a tubular outer casing 2, a concentric inner casing running-liner 4 with generally radially inwardly extending wall means in the form of longitudinally extending vane deflectors 6, which form a stator for the vane motor 1 and a rotor 8 having vane means 18.

The rotor 8 is mounted in suitable bearings 9a, b for rotation within the casing 2. The inner-casing 4 is provided with angularly spaced apart inlet 10 and outlet 12 conduits to allow for respectively the ingress of pressurized working fluid 11 into a chamber 14 between the rotor 8 and the inner-casing 4, and the egress of worked or exhausted fluid from within the chamber 14. (For improved clarity the direction of movement of fluid is shown by small arrows 'A'). The inlet conduit 10 is separated from the outlet conduit 12 by the longitudinally extending vane deflectors 6. The vane deflectors 6 are diametrically opposed to each other and extend into the casing so as to be nearly substantially in contact with the outermost extending periphery 16 of the rotor 8.

The rotor 8, which rotates in the casing in the direction of arrow 'B', has six equiangularly spaced apart vane means in the form of vanes 18 (see also Fig. 3-5). The vanes 18 are hingedly mounted 22 in 'V'-shaped section recesses 20 in the rotor 8 such that the vanes 18 are hingedly displacable between a radially projecting position with a tip portion 24 of the vane 18 in sealing engagement with the inner-casing 4 (position 'Z'), and a rearwardly inclined and radially inwardly retracted position (position 'Y') when traversing the longitudinally extending vane deflectors 6. Each deflector 6 has a rising portion 6a which progressively approaches the periphery 16 of the rotor 8 and a falling portion 6b which recedes from the rotor 8. The tip portion 24 remains in sealing engagement with van deflectors 6 as it passes it over it.

With reference to Figs. 3 and 4, the vane 18 is in the form of elongate strip of plastics material mounted to a shaft 26 which has end portions 26a, b which extend beyond the elongate strip of the vane 18 for mounting, via bearings 27, of the vane 18 to a vane mounting plate 29. The vanes 18 have a plurality of spaced apart fluid transfer ports 28 to allow working fluid to pass through from the trailing face 18a of the vane 18 to the leading face 18b as the vanes hinge between the radially

projecting position and the rearwardly inclined position. The shaft 26 has several longitudinal grooves 27 (shown only in Fig. 3 and 4) to provide a reservoir for lubricating material and to reduce friction as the vane hinges between the two positions. The 'V'-shape recesses 20 have at their root 29 a similar shape to the shafts 26 for captively retaining in a ball and socket type arrangement the vanes 18 in the recesses 20. Worn vanes may be replaced by removing the vane mounting plate 29 and sliding the vanes out of the recesses. The alternative embodiment shown in Fig. 4 has a tip portion 24 which is of the same shape as the shaft 26 of the embodiment in Fig. 3. This arrangement allows for a vane with a worn tip portion to be reversed so as to place the worn tip portion in the recess so as to be captively retained.

The 'V'-shaped recesses 20 of the rotor 8 have a leading face 30 against which a vane lies when being subjected to pressurized working fluid and a trailing face 32 which a vane approaches and lies against as its tip portion 24 traverses the vane deflectors 6.

The outer circumference of the rotor 8 adjacent the trailing faces 32 of the recesses 20 is provided with a shallow concave-section groove 34 so as to increase the volume of the chamber 14 defined by the rotor 8 and the

casing 4. The rotor shown in Fig. 1 shows also a second embodiment of rotor 8 where the outer circumference of the rotor 8 shown at the 4 o'clock and 6 o'clock position is flat 36.

The rotor 8 has a central axial bore 38 to allow working fluid to pass through the motor 1 for cooling and/or lubrication purposes for a drill bit 40 (only partially shown) or other tool attached to the motor.

The illustrated motor is mainly utilised in down-hole applications and is particularly useful for directional drilling. Pressurised drilling fluid or mud is used to rotate the motor rotor 8 and thereby to drive the drill bit 40. The fluid enters the chambers 14 through the inlet ports 10 and exits through outlet ports 12. As may be seen in Fig. 1, two first pairs of vanes 18^6, 18^3 and 18^4, 18^1 are exposed to high pressure working fluid entering through the inlet ports 10 at their trailing face 18a thereby exerting a clockwise (as viewed in Fig. 1) turning moment on the rotor 8. The other pair of vanes 18^5, 18^2 are pressed down into their retracted positions by the vane deflectors 6. When the rotor 8 has turned approximately 20° further in the clock-wise direction under the influence of the fluid pressure on the first mentioned vanes 18^6, 18^3 the retracted vanes 18^5, 18^2 will clear the vane deflectors 6 and be

restored by fluid pressure into their projecting positions 'Z' with their trailing face 18a exposed to the hydraulic pressure of the working fluid entering through the inlet ports 10 and so in turn exerting a turning moment on the rotor 8 thereby ensuring a continuous rotating and driving force on the rotor 8 with a torque substantially directly proportional to the pressure of the working fluid.

The exhausted working fluid at the leading faces 18b of the vanes 18 is compressed between the advancing leading face 18b and the respective opposed vane deflector 6 and displaced longitudinally along the chamber to be expelled out of the outlet ports 12 at the longitudinally downstream end of the inner casing 4, into an annular outlet conduit means 42 defined between the inner and outer casings 4, 2 and separated from inlet conduit 10 between the inner and outer casings 4, 2 at their upstream ends adjacent the inlet ports 10, by an annular bearing seal 44. Conveniently the vane deflectors 6 could be inclined slightly so as to wind helically clockwise as viewed in Fig. 1 towards the lower outlet end of the motor so as to facilitate progessive longitudinal displacement of exhausted working fluid towards the outlet ports as the rotor vanes 18 advance. Alternatively the vane 18 could be formed with a slight helical twist so as to provide a

similar effect without departing from the scope of the present invention.

Fig. 6 shows a further embodiment in which like parts corresponding to those in Fig. 1 are indicated by like reference numerals. In this embodiment each vane 118 has a generally wedge-shaped enlarged angular extent root portion 119 which is captively retained under an overhang 121 of the generally V-shaped section recess 120 in the rotor 108 so as to allow a hingeing movement of the vane between its radially retracted and projecting positions - indicated at Y and Z, respectively. Between the central axial bore 38 in the rotor 108 and the rear face 123 of the undercut portion 125 of each V-shaped recess 120, extends a passage 127 for allowing working fluid to flow into the undercut portion 125 to facilitate forward movement of the vane 118 and allowing working fluid to flow back out the undercut portion 125 to facilitate retraction of the vane 118.

In order to help reduce possible wear at the radially inward edge 129 of the vane 118, this, along with the base 131 of the V-shaped recess 120 may be bevelled or rounded off as shown at 129^1, 131^1 in the vane 118 at the 2 o'clock position.

Further modifications may also be made without departing from the scope of the present invention. Thus, for example, the inward edge of the vane could be provided with an enlarged width generally cylindrical section portion somewhat like the root portion 22 of the vane 18 of Fig. 1 for a hingeing keyhole like engagement in a complementary channel at the base of the V-shaped recess 120. Also either or both of the opposed part-cylindrical surfaces 131, 133 at the underside 135 of the overhang 121 and the upper face 137 of the enlarged angular extent root portion 119 of the vane 118, is (are) provided with grooves of the like for providing lubrication therebetween.

CLAIMS

1 An hydraulically or pneumatically driven hinged vane motor suitable for use in down-hole drilling applications, characterised in that said motor is a vane motor and comprises a generally tubular casing (1,2) and an ellipsoidal inner stator (casing) (4) mounted within the said generally tubular casing and a rotor (8) mounted for rotation within the said stator utilizing a number of hinged vanes (18), the root portion (22) of the vane means (18) being located in a channel grooved into the rotor and substantially radially spaced therefrom so as to define a chamber (14) therebetween, said casing (1,2) being provided with angularly spaced apart inlet means (10) for ingress of pressurised working fluid from inlet conduit means (10) in said stator into said chamber (14) and egress of said fluid from within said chamber, to outlet conduit means (12) separated from said inlet conduit means (10) by wall means (4) , in use of the motor, said stator (4) having generally radially external wall and generally ellipsoidally internal wall means extending substantially into contact with said rotor (8) at an angular position between said outlet means (12) and said inlet means (10), said rotor (8) having a plurality of angularly spaced apart hinged vane means (18), said ellipsoidal wall means and said vane means being displacable from generally ellipsoidally narrowing configuration in substantially sealing engagement with said rotor (8) or said stator, respectively, to a generally retracted configuration when traversing the other of said ellipsoidally narrowing wall means and said hinged vane means, said hinged vane means and inlet means (10) being formed and arranged and relatively angularly disposed so

that, in use of said motor, a flow of pressurised fluid into said chamber (14) acts against an upstream side of the hinged vanes (18_6, 18_3, and 18_4, 18_1) so as to rotate said rotor (8) while venting fluid from its downstream side (18_5, 18_2) until said vane means (18) traverses said outlet means (12) and a second vane means (18) traverses the inlet means (10) whereupon said process is repeated.

2 A hydraulically or pneumatically driven hinged vane motor according to Claim 1, wherein said casing comprises a generally tubular outer casing (1) and a generally ellipsoidal inner stator (casing) (4) and said inlet and outlet conduit means (10, 12) are defined between said outer casing and said stator.

3 A hydraulically or pneumatically driven hinged vane motor according to Claim 2 wherein said wall means between said inlet and outlet conduit means (10, 12) comprises an annular wall (44), said inlet and outlet conduit means comprising longitudinally spaced apart annular passage means(10, 12) at opposite sides of said annular wall.

4 A hydraulically or pneumatically driven hinged vane motor as claimed in claims 1 to 3 wherein the high pressure working fluid or gas is directed from inlet (12) in an angular flow across the face of the hinged vanes directing the tip portion of the said hinged vanes to be in a substantially sealing engagement with the inner wall of the said stator (4).

5 An hydraulically or pneumatically driven hinged vane motor as

claimed in claims 1 to 4. wherein said vane means(18) are hingedly mounted within radially or V shaped channels provided

6 An hydraulically or pneumatically driven hinged vane motor as claimed in claims 1 to 5, wherein the vanes have fluid passages (28) located down their length to allow the working fluid to pass from a high presssure area to a low pressure area when the vane is traversing from a collapsed position to a substantially projected position thereby neutralising any fluid entrapment between the vanes and the said rotor .

7 An Hydraulically or pneumatically driven hinged vane motor as claimed in claims 1 to 6, wherein the rotor has multiple channels cut down the length of leading face (30) and trailing face (32) to relieve trapped fluid presure against which the hinged vane lies when being subjected to pressurised working fluids.

8 An hydraulically or pneumatically driven hinged vane motor as claimed in Claim 1 to 7, having the vanes tip portion (24) in constant wall contact with the stator by means of constant working fluid pressure being directed through fluid passages (127) to the base of the Vanes from annulus (38) located in the centre of the rotor.

9 An hydraullically or pneumatically driven hinged vane motor as claimed in claims 1 to 8, having the vanes suspended within the grooved rounded socket or V shaped recesses (120) of the rotor from a remote plate

(29) situated above the rotor thereby eliminating friction on the bottom plate created by the downward directed force of the of the working fluid being applied to the said hinged vanes.

10 An hydraulically or pneumatically driven hinged vane motor as claimed in claims 1 to 9, having the vanes supported within the rotor by a remote plate (29) situated below the rotor.

11 An hydraullically or pneumatically driven hinged vane motor as claimed in claims 1 to 10, wherein the hinged vanes suspended in the rotor, rotate within an ellipsoidal stator (4) allowing for the working fluid to ingress through conduit (10) at the top end of the stator and egress at the lower end of the stator through conduit (12) thereby driving the hinged vanes in an uninterrupted clockwise path within the ellipsoidal stator (4).

12 An hydraulically or pneumatically driven hinged vane motor as claimed in any preceding claim wherein the rotor has large shaped recesses (20) extending down the length of its body restricting the hinged vanes to traverse only from the collapsed position to the projected position the walls of these said recesses are shaped to set at such an angle that when the hinged vanes are in a collapsed position the tip portions of the vanes are kept in substantial engagement with the internal wall of the ellipsoidal stator at its narrowest point and conversely when the vanes are in their most projected position the opposite wall is of such an angle to allow the tip

portions of the vanes to remain in close contact with the internal wall of the ellipsoidal stator at its widest point.

13 An hydraulically or pneumatically driven hinged vane motor as claimed in any preceding claim wherein the rotor has large semi-circular shaped recesses creating a chamber (14) to accept and direct viscous working fluids to the hinged vanes vanes.

14 An hydraulically or pneumatically driven hinged vane motor as claimed in any preceding claim wherein the said hinged vane means (18) is mounted in a generally radially extending recess (20) or V shaped recess (120) so as to be slidably replacable.

15 An hydraulically or pneumatically driven hinged vane motor as claimed in any preceding claim wherein the hinged vane (18) may have multiple grooves providing a bearing surface (27) along its length allowing fluid to lubricate and reduce friction this type of hinged vane maybe reversed to reduce friction on the internal wall of the stator.

16 An hydraulically or pneumatically driven hinged vane motor as claimed substantially as herein described and illustrated in the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) 20	Application number GB 9415321.0
Relevant Technical Fields (i) UK Cl (Ed.N) F1F (FD, FEC, FEH, FEW) (ii) Int Cl (Ed.6) F01C (1/40, 1/44); F04C (2/40, 2/44, 18/40); F04C (18/44)	Search Examiner C J DUFF Date of completion of Search 21 JULY 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- 1-16

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
Y	GB 1545583	(EMPIRE)	1, 2, 3, 5, 13, 14
Y	GB 1383812	(CENTRUM)	1, 2, 3, 5, 13, 14
Y	GB 1358162	(MAYALL)	1, 5

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).